VEHICLE WINDOW REGULATOR HAVING A FLOATING WINDOW CARRIER

Field of the Invention

This invention relates to a window regulator, as used in a vehicle door.

Background of the Invention

A window regulator is a mechanism under which control a vehicle window, e.g. a passenger door window is raised and lowered. Various types of window regulators are known.

In modern vehicles, auto windows are generally curved, having a major outwardly convex surface. A side door window, for example, thus has a forward upright edge and a rearward upright edge, each located in an arcuate guide rail which defines a travel path followed by the window as it moves between upper and lower positions. It is in this context that advantages of the invention described herein would be most apparent.

Summary of the Invention

According to one aspect of the invention a window regulator is provided which includes a linear element, such as a frame or rod, that defines a first axis. A runner is mounted to translate linearly along the linear element. A window carrier is pivotally and slidably connected to the runner so as to translate along a second axis substantially orthogonal to the first axis and rotate about a third axis substantially orthogonal to both the first and second axes. This device enables an arcuate window to be mounted to the window carrier. The window is slidably mounted in at least one glass run channel having

a curvature substantially identical to the curvature of the window. When the runner is translated along the linear element using any suitable means, the runner follows a linear path but the window and window carrier will follow an arcuate path dictated by the glass run channels.

According to another aspect of the invention, a window regulator is provided having a runner that travels along a guide rod. A carrier is connected to the window, and the runner engages the carrier to force the window up and down as the runner travels along the guide rod. The engagement of the runner and carrier provides for movement of carrier along the travel path of the window without necessarily precisely following the travel path of the runner.

The upright edges of such a window are engaged by guide rails within the vehicle door, the guide rails being generally arcuate to match the arcuate shape of the window, and to define the travel path of the window as it moves up or down. The carrier, e.g. support plate, affixed at the bottom of the window must follow the arcuate travel path of the window. The runner, which is forced by a generally conventional means to move up and down along the guide rod engages the carrier. Because the invention permits the window carrier to move with respect to the rod in a direction that is not precisely parallel to the travel path of the runner, the rod is not required to be in the shape of the travel path of the window, that is, the rod is not required to have the arcuate shape of the rail guides.

Automotive doors come in a variety of shapes and sizes, and so too do their windows. Windows thus have differing degrees of curvature, which of course determines the different travel path each must follow when being raised and lowered. Because the travel path of the runner, i.e., the shape of the guide rod is not required to match the

curvature of the window guide rails, a lift mechanism of the present invention (outside of the guide rails) can be used with windows of differing degrees of curvature.

In one of the embodiments described below, one or the other of the runner and the carrier preferably includes a pair of channels generally traverse to a major window surface (i.e., generally orthogonal to the travel of the runner) and the other of the runner and the carrier includes a pair of trunnions. Each trunnion is received in one each of the channels and each trunnion includes a surface which is shaped to engage a surface of the channel into which it is received to permit, as the runner travels in an axial direction along the rod, movement of the carrier along the arcuate travel path of the window.

Other means for slidingly and pivotally connecting the carrier to the runner are described in greater detail below.

Brief Description of the Drawings

A detailed description of the invention, including the best mode of the invention currently known or contemplated by the inventor is set out below, reference being made to the attached drawings in which:

Figure 1 illustrates generally a vehicle side door having a window regulator assembly according to the invention installed therein;

Figure 2 is an isometric view showing the components of a drive mechanism according to a first embodiment of the invention;

Figure 3 is a view similar to that of Figure 2, showing a carrier plate for the window installed;

Figure 4 is an isometric view showing the inner and lowers sides of the carrier plate shown in Fig. 3 in relation to certain drive components;

Figure 5 is an isometric view showing the outer and upper sides of the carrier plate shown in Fig. 3;

Figures 6A- 6C are cross-sectional views of the first embodiment showing the position of a runner in a channel of the window carrier plate as the window is moved from a lower, open position (Fig. 6A) to an upper, closed position (Fig. 6C);

Figure 7 is an exploded view of an alternative runner and slider combination;

Figures 8A and 8B are isometric views showing the components of a drive mechanism according to a second embodiment of the invention;

Figures 9A and 9B are detailed views of regions IX-A and IX-B of Figs. 8A and 8B, respectively;

Figure 10 is a detailed elevation view of the second embodiment;

Figure 11 is a view similar to that of Fig. 10, showing a variant window carrier plate and variant connection between the carrier plate and runner;

Figures 12A and 12B are detail elevation views showing another variant of second embodiment, having a runner modified for convenience of installation of a window and carrier plate; and

Figures 13A and 13B are isometric views showing a third embodiment, in which an arm, pivotally mounted to a runner, supports the carrier plate.

Detailed Description of Preferred Embodiments

Turning to the drawings, a window regulator assembly **12** is schematically illustrated in Fig. 1. The assembly **12** is installed as part of vehicle side passenger door **10** and includes a linear lead screw or threaded drive rod **16**, rotatably mounted on a frame 32. A carrier plate **18** is slidingly mounted to the frame and also slidingly and pivotally mounted to the drive rod, as described in greater detail below. An arcuate window **20** is mounted to the carrier plate **18** at the lower edge of the window. The assembly **12** includes arcuate forward and rearward glass run channels **22, 24** which receive, respectively, the forward upright edge **26** and rearward upright edge **28** of the window **20**. As described in greater detail below, rotation of the drive rod **16** leads to axial and pivotal movement of the carrier plate **18** therealong corresponding to the arcuate travel path of the window **20** as it rides upwards and downwards in the arcuate glass run channels **22, 24**.

Figure 2 is an isolated view of the drive components of window regulator assembly **12** according to a first embodiment. The assembly **12** includes a longitudinal base frame **32** secured within the interior of the door at both ends thereof. The drive rod

16 is journaled for stationary rotation in the frame **32** via bushings **33**. The actuator, such as electric motor **14** coupled to a gear reducer **15**, is drivingly connected to the lower end of drive rod **16** by any suitable manner known in the art, such as through the use of gears, a belt drive, a flexible cable or a universal joint, in order to rotate the drive rod about its central linear axis **34**. A runner **36** having an internal threaded bore **38** is threadingly mounted on the drive rod. As will be explained further below, in the fully assembled mechanism, runner **36** is prevented from rotating with respect to the drive rod, and thus the runner travels axially along the drive rod when it rotates, either up or down, depending upon the direction of the rotation. The travel path of the runner thus parallels the central linear rotational axis **34** of drive rod **16,** and thus the drive rod essentially acts as a guide rod for the runner. Runner **36** includes trunnions **40a, 40b** which have an elliptical cross section, the purpose of which will be described in greater detail below. Base frame **32** includes an integrally formed guide **42** having the same arcuate bend as window channel runs **22, 24**, the function of guide **42** being described further below.

Figure 3 is similar to Fig. 2, but shows carrier plate **18** installed on frame **32**. Referring additionally to the isolated view of Fig. 5, carrier plate **18** includes a primary channel **44**, which is generally axially upright when installed. The channel **44** receives the longitudinal body portion **46** of runner **36**. The trunnions **40a, 40b,** which protrude from the longitudinal body portion **46** of runner **36**, seat in secondary channels **50a, 50b,** respectively, cut into sidewalls **64** carrier plate **18**. Carrier plate **18** also defines slider channels **52a, 52b,** which receive guide **42** of frame **32**.

Plate **18** is rigidly affixed to window **20** by means of fasteners (not shown) received through plate apertures **56** that communicate with suitably located apertures in the window. Further support is leant to the plate-window connection by protruding plate

support **58** (Fig. 5) on which the lower edge of the window rests. Many other techniques for attaching glass to the carrier plate are well known in the art and may be used in the alternative.

The upward and downward motion of runner **36** is caused by rotation of drive rod **16** under control of the actuator. The runner **36** is prevented from rotating with respect to drive rod **16** because longitudinal body portion **46** of runner **36** is ensconced in the primary channel **44** of carrier plate **18**, abutting the side walls **64** thereof. More particularly, the cross-sectional shapes of the surfaces defining the primary channel and the longitudinal portion of the runner match each other sufficiently to affix the runner against rotation about the axis of the drive while at the same time permitting the required degree of movement of the runner in other directions within the channel, described further below. Central axis **34** of drive rod **16** is linear so the travel path of runner **36** as it travels between the upper and lower positions shown in Figure 1 is also linear. Window **20** and plate **18** follow parallel arcuate travel paths as defined by rails **22, 24** and guide **42**, an arcuate axis of each of these being parallel to the arc indicated by arrow **30**. The arcuate path followed by the plate, the upward and downward motion of which is driven by the runner, which itself follows a linear path, is accommodated by elliptical surfaces **60** of the trunnions which bear on surfaces **66, 68** of the secondary channels of the plate. In other words, the elliptical cross-section of the trunnion surfaces which bear on surfaces of the secondary channels of the carrier plate permit the plate to pivot slightly and to move towards or away from drive rod **16** (in a cross-car direction) as necessary to accommodate the non-parallel travel paths of the plate and runner. This is shown in the cross-sectional views of Figs. 6A - 6C which illustrate the position of the runner **36** within the channel **44** as the window moves from a lower, open position (Fig. 6A) to an

upper, closed position (Fig. 6C). It will further be appreciated that guidance of the plate along the travel path of the window (as determined by guide rails **22, 24**) is further assured by the fit of guide **42** on base **32** within slider channels **52a, 52b**, which precludes undue stress from being placed on the window. In preferred embodiments, the window and glass run channels will also have a uniform radius of curvature which is imparted to the slider channels.

A variant of the first embodiment is shown in Fig. 7 in which trunnions **66a, 66b** of runner **68** are received within gliders **70a, 70b** having apertures **72a, 72b**. The gliders, in turn, are mounted in the secondary channels of the carrier plate.

It will be noted from the foregoing the arcuate guide **42** enables the length of the glass run channels **22, 24** to be minimized. That is, the glass run channels do not have to be the full height of the window travel since the guide/frame can support the window and its arcuate travel.

Figures 8A, 8B, 9A, 9B & 10 illustrate a second embodiment of the invention. Here, channel frame **100** has an upright threaded drive rod **102** rotatably mounted thereto. The top end is thus suitably journaled to the frame, with the lower end drivingly connected to motor **104**. A runner **106** is seated within channel **108** of frame **100**, the channel **108** being of relative constant cross section along the travel path of the runner, with the outer cross section of the runner generally matching the cross section of the channel. The runner is again rotatably mounted on the drive rod, the matching surfaces of the runner and the channel into which it is received precluding rotation of the runner within the channel so that rotation of the drive rod results in the travel of the runner.

The runner **106** has an arm **110** protruding from the channel frame **100** and a carrier plate **112** is mounted to the arm **110**. More particularly, arm **110** includes a slot

114, which lies in a plane generally orthogonal to the axis of screw **102**. A carrier mounting shaft, bolt **116**, is received within slot **114**. Bolt **116** provides an axis of rotation **118** for the carrier plate, which axis is parallel to the plane of the slot and orthogonal to the rotational axis of drive rod **102**. Mounting bolt **116** is also free to move parallel to the plane of slot **114**, towards and away from screw **102**, which corresponds to the cross-car direction in the case of the mechanism being installed in a passenger door of an automobile. Carrier plate **112** includes abutment walls **120a**, **120b**, which walls abut side walls **122a**, **122b** of runner arm **110** to substantially limit translational movement of the plate to movement towards and away from the lead screw, i.e., to preclude movement of the axis of rotation of the carrier plate to being within the plane of the slot.

Channel frame **100** includes mounting members **124**, **126** for affixing the window drive mechanism to the automobile, as within the interior of a car door. Again, the rotation of the carrier plate about axis **118**, and translation of the plate in a direction parallel to the plane of slot **114**, provides for the arcuate movement required of the plate as it moves up and down along the rotating drive rod, despite the fact that the frame and the drive rod are linear in configuration.

In a variant of the second embodiment, shown in Fig. 11, runner trunnions **132** are received within carrier plate slots **134**, only one of each being illustrated in Fig. 11.

For ease of installation, runner arm **110** may include an opening into which is slidingly received separate slotted member **138**. When in the open position as illustrated in Fig. 12A, in which member **138** is drawn away from the base portion of the runner arm, gap **140** is provided between the overhanging portions **142**, **144** of the slotted member and the base of the arm, respectively. When the slotted member is in this position, bolt **116** of the carrier plate can be received into the slot, the slotted member slid

into the closed position of Fig. 12B for installation of the carrier plate and window. Suitable securing means is provided to hold the slotted member in the installed position to the runner arm.

In the case of the second embodiment, as illustrated, the travel path of the carrier plate is not fixed with respect to the channel frame (as for example, by guide **42** and slider channels **52a**, **52b** of the first embodiment). The travel path is thus defined by only by glass run channels **22**, **24** suitably mounted to the automobile. See Figure 1. One of the advantages of this embodiment is that the window travel is not dictated by the curvature of the window regulator rail which, as a result of manufacturing tolerances, may differ from the curvature of the glass run channels. This enables the system to be used in a wide variety of vehicle doors since the rail does not have to be specifically manufactured for various vehicle models. In order to further augment this capability, the carrier plate can be configured to receive a bracket to which the window pane is bonded with a suitable adhesive.

A third embodiment of the invention is illustrated in Figs. 13A and 13B. Here, arm **200** is pivotally connected to runner **202** at first end **204** having first axis of rotation **206**. Carrier plate **208** is connected to the arm at second end **210**. Each pivotal connection provides for rotation about an axis that lies in a plane orthogonal to the axis of rotation of the lead screw, and which is also orthogonal to the axis of the drive rod. The two axes of rotation **206**, **212** are thus generally parallel to each other. Again, this arrangement permits movement of the carrier plate with respect to the arm and movement of the arm with respect to the runner, as the runner moves along the drive rod provides for the movement required of the plate as it moves up and down along the rotating drive rod.

It will be appreciated that a motor of the mechanism can be conveniently mounted through appropriate helical or bevel gears, belt drive, etc. to rotatingly drive the drive rod. Rotation in first angular direction (e.g. clockwise) leads to lifting of the carrier plate and window, and rotation of the drive in a second direction, opposite to the first (e.g., counterclockwise) leads to a lowering of the window. Alternative drive mechanisms to a rotating lead screw or drive can be used. For example, in the second embodiment, the raising and lowering of the runner along the rod guide can be achieved through the use of a cable and drum mechanism, synchronous cable, etc.

The illustrated embodiments have been described with particularity for the purposes of description. Those skilled in the art will appreciate that a variety of modifications may be made to the embodiment described herein without departing from the spirit of the invention.